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ABSTRACT

This paper explores the possibility of integrating cognitive theory into an established instructional development model, i.e., Gagne's nine events of instruction. Based on the third edition of Gagne's book, this paper describes the most up-to-date notions of how cognitive theory impacts on this development framework. Each of the nine events is presented in a separate section, together with the learning process associated with that instructional event and current cognitive theories as they relate to it: (1) Gaining Attention. Reception of patterns of neural impulses; (2) Informing the Learner of the Objective. Activating a process of executive control; (3) Stimulating Recall of Prerequisite Learnings. Retrieval of prior learning to working memory; (4) Presenting the Stimulus Material. Emphasizing features for selective attention; (5) Providing Learner Guidance. Semantic encoding; cues for retrieval; (6) Eliciting Performance. Activating response organization; (7) Providing Feedback about Performance Correctness. Establishing reinforcement; (8) Assessing the Performance. Activating retrieval; making reinforcement possible; and (9) Enhancing Retention and Transfer. Providing cues and strategies for retrieval. It is concluded that, although not all of the events of instruction match up perfectly to cognitive theory, cognitive apprenticeship, or microworlds from constructivistic learning theory, instructional developers can keep the field in a state of growth by conducting further studies of new learning theories and how and if they are complementary to existing theories of instructional development. (25 references) (BBM)

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Title:

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Integrating Cognitive Theory into Gagné's Instructional Events

There has been a great deal of discussion about integrating cognitive theory into the development of instruction (Merrill, Li, & Jones, 1990; Orey & Nelson, 1991; Wildman & Burton, 1981; Winn, 1989). Some of the approaches have been quite radical (Merrill, Li, & Jones, 1990; Orey & Nelson, 1991; Winn, 1989). This paper will explore the possibility of integrating cognitive theory into an established development model -- Gagné's nine events of instruction. Rather than discarding the old theory and replacing it with the new -- a Popperian approach to the development of science (Popper, 1968) -- we suggest here that the field of instructional development might take the less radical form of scientific development as described by Lakatos (1978). This second form is more evolutionary than revolutionary. Hence, we will attempt to describe how current cognitive theory might evolve into our instructional development models.

Specifically, we will describe how cognitive theory might have an impact on development decisions related to Gagné's events of instruction (Gagné, Briggs, & Wager, 1988). We will use the third edition of Gagné's book to describe the most up-to-date notions of how cognitive theory impacts on this development framework. Each section of the following text examines an event of instruction. Each section includes the name of the event, the learning process associated with that instructional event, and then the textual discussion of the current cognitive theories as they relate to that event.

1. Gaining Attention. Reception of patterns of neural impulses (Gagné, Briggs, & Wager, p. 182). In terms of attention, there is a great deal of cognitive research that can have an impact on this first event of instruction. To gain and maintain attention, one needs to examine a model of attention. Norman (1976) provides the most cohesive model of attention within the information processing system. After the initial perception or pattern recognition, there is a component of memory which Norman calls "Memory Recognition" which accesses Long Term Memory (LTM). This component of memory functions on the basis of pertinence for the individual. Pertinence can be something as clear as the learner's name or as ambiguous as a scent in the air which evokes a sense of nostalgia. It should be noted in passing that this memory recognition phase is at a "deeper" level of processing than that suggested by Gagné's definition -- *Reception of patterns of neural impulses.* Gagné's definition describes perception, not attention. The question is, how does this effect the development of instruction?

Earlier attentional models focussed on the physical characteristics of the stimulus (Broadbent, 1958). Such attributes as -- the originating location of the stimulus, the volume of a sound, the brightness or different color of an image -- would cause an individual to attend to that stimulus. The later models attempted to account for such phenomena as the ability to recognize your own name being spoken in a noisy room. Norman (1976) as well as others (Shiffrin, 1976) suggested alternative models that would account for these types of phenomena.

The result is that attention is not only influenced by loud or unique stimuli, but also the context of the stimulus. The implication for this event of instruction is that attention may be achieved by using relevant stimuli as well as strange creative sounds or images. Other implications of attentional theory relate to the maintenance of attention which might be better addressed across events -- something described at the end of the paper.

2. *Informing the Learner of the Objective. Activating a process of executive control.* (Gagné, Briggs, & Wager, p. 182). Gagné implies that by providing the learner with the objectives, the learner can invoke a cognition about one's own learning. Metacognition means that one can have conscious control over one's learning or thinking (Brown, 1975). Metacognitive strategies include such things as, selecting memorial strategies for varying types of lists (choosing a mnemonic, for example), visualizing, taking notes, and selecting key words in a text to aid in comprehension. However, there is nothing inherent in a behavioral objective that would cause a learner to invoke any of these strategies. For example, a Gagné behavioral objective with its five components might be -- *[Situation:] Using a paper and pencil, [learned-capability:] list [object:] Gagné's nine events of instruction [action:] by writing them [tools and other constraints] without the use of notes, in order, and without error.* This statement establishes the goal for the student, but there is no indication about what if any executive control/metacognitive strategy should be used. If the intent of stating the objective is to *activate a process of executive control*, then it might be more appropriate to inform the learner of the task and how they might accomplish that task. This might change the above objective to -- *[Situation:] Using a paper and pencil, [learned-capability:] list [object:] Gagné's nine events of instruction [action:] by writing them [tools and other constraints] without the use of notes, in order and without error. To do this you might use a [activate a process of executive control:] mnemonic device such as an acronym or a key word method.* Afterall, not all learners are equally adept at selecting memorial strategies, so stating how the learner might learn may be quite appropriate. If the purpose of *informing the learner of the objective* is to *activate a process of executive control*, than that process ought to be stated explicitly as part of the objective. Certainly, learning and memory strategies ought to be included as part of the fourth event of instruction -- *presenting the stimulus material.*

On the other hand, Gagné also includes *expectancies* as a part of his learning model. It might be inferred that stating the objective will cause the learners to establish what behavior is *expected* of them. This definition, however, is more related to behavioral learning theory than that of cognitive theory. In cognitive psychology (we looked in several texts on cognitive psychology and the root word expectancy was not listed in the subject index, Flavell, 1985; Glover, Ronning, & Bruning, 1990; Zechmeister, & Nyberg, 1982), expectancies might be interpreted from either a prior knowledge standpoint or schema theory standpoint. In this interpretation, the learner develops expectancies about certain characteristics of their environment. The learner has come to know that when the instructor states the behavioral objectives, that the instructor is

indicating a behavior that should be performed. This is different from a behavioral interpretation and several of the authors' of the current paper believe that the establishment of an expected behavior is not a bad thing for instruction. The act of goal setting is a powerful motivator in many contexts (Bandura, 1986).

3. Stimulating Recall of Prerequisite Learnings. Retrieval of prior learning to working memory. (Gagné, Briggs, & Wager, p. 182). This event is particularly compelling from the cognitive perspective. In order to develop cognitive structures (in other words, learning), one must tie what is being learned to what one already knows. Regardless, if the cognitive view is constructivist (e.g., schema theory) or information processing, the importance of prior knowledge is vital. In the schema view, the stimulation of prior knowledge will aid in the activation of appropriate schema and perhaps their modification as the result of learning. This activation of a schema aids in both the interpretation of events as well as the storage of those related memories. In the information processing view, where memory is in an associative network, the stimulation of previous knowledge identifies associations that need occur. In other words, tie the new learning to the old.

4. Presenting the Stimulus Material. Emphasizing features for selective attention. (Gagné, Briggs, & Wager, p. 182). Perhaps the most powerful application of cognitive theory to the design of instruction would be brought to bear on this event. Mayer's (1989) research on models would be effective here. Anderson's (1987) work on the development of declarative and procedural knowledge would also be a powerful construct for this event. Resnick's (1982) distinction between syntactic and semantic knowledge would effect the nature of presentation. Collins' and Loftus' (1975) network model of memory would effect how the material to be learned was organized. Metacognition (Brown, 1975) would also play an important role in the design of this event. Afterall, this is where the learning of the material takes place. The nature of the content, the organization of the content, and how the content interacts all may impact on how the information might get transferred from short term memory (STM) to LTM. Other cognitive notions that ought to impact on this event of instruction are such notions as encoding processes, knowledge as chunks of information (Miller, 1956), and parallel distributed processing (McClelland, 1988). In addition, attentional theory as well as motivational theory plays an important role in maintaining the learner's attention.

5. Providing Learner Guidance. Semantic encoding; cues for retrieval. (Gagné, Briggs, & Wager, p. 182). By semantic encoding, I assume that Gagné means elaboration, since he describes this process as one which allows the learner to move the material to LTM. It is generally accepted that information in LTM is permanent, but that people forget how to retrieve that information after awhile. Therefore, the more cues that elicit recall, the more likely the learner will be able to recall the information or the better learned the material is. There are a variety of cognitive constructs that can guide the developer when making design decisions at this phase of development. They all revolve around the notion

that the more cues or links that one has for retrieving information, the more likely it is that one can do it. The first construct is that of massed versus distributed practice. A learner who is presented five opportunities to work on a specific task on five separate days (perhaps for a total of 50 minutes) will be able to perform better than a learner who is presented with those same five opportunities consecutively on the same day (also for 50 minutes). The psychological explanation for this phenomena is that the learner who receives the distributed practice may bring fresh ways of encoding the information that the massed practice learner will not do.

A second notion is that of context specific learning. If the material is presented in a variety of contexts, there will be more links to the information. Encoding specificity refers to the phenomena that occurs when the learner is provided with only a narrow context. The learner is unable to draw up that knowledge in other contexts. For example, if you learn material in one classroom, you will be able to recall the information better in that classroom than a different classroom. Ginsberg (1977) describes a child who was able to perform multi-digit subtraction at the end of the school year without error. However, at the beginning of the next school year the child performed all problems incorrectly. Upon closer examination, it was determined that the child learned to start the problem in the column closest to the piano, and the next year the piano was on the opposite side of the room.

Other factors that might be considered when developing instruction from a cognitive approach would be interference theory. Both proactive and retroactive interference can contribute to the failure of learning. In one case the new material interferes with the old and in the other the old interferes with the new. This effect is widely demonstrated with materials that are new to the learner or materials that require rote memorization. A second consideration which is directly related to interference is that of frequency. The more times you practice the better you will be given that you are provided with appropriate feedback (Event 7).

6. Eliciting Performance. Activating response organization. (Gagné, Briggs, & Wager, p. 182). It is not altogether clear what is meant by *response organization.* The nine internal processes that are described on page 11 (Gagné, Briggs, & Wager, 1988) do not include this term. However, he does depict a process of *response generation* that makes use of information from both LTM and STM. The example given is that of getting the learner to actually write the plural form of the word *appendix*. This would require the learner to retrieve from LTM the rule for performing this task and then applying the rule to this particular instance. Once the rule is applied, a response would then be generated and either voice or hand output would be initiated. This appears to be a cognitive process. However, more recent work in cognitive psychology tends to focus on process rather than product. The emphasis changes from what the observable behavior is to what that behavior indicates about the process the leaner went through to generate that particular behavior. This leads to the next event.

7. Providing Feedback about Performance Correctness. Establishing reinforcement. (Gagné, Briggs, & Wager, p. 182). Although reinforcement is a construct in learning theory, it is not a construct in cognitive learning theory. This does not mean that reinforcement suddenly does not work. It does. However, this paper is addressing cognitive theory applied to instruction and reinforcement is not a part of cognitive theory. Feedback, on the other hand, is an issue within the field and there is extensive research on the what, when and how of providing feedback. Most notably the work being done with intelligent tutoring systems (Wenger, 1987) and the research area of cognitive science (Anderson, 1987) has contributed to this area. Much of this research focuses on how the learner is responding (their solution process) and providing the specific feedback to modify the solution process so that a correct response can be generated. This does not relate to reinforcement -- a theory ladened term from operant conditioning research.

8. Assessing the Performance. Activating retrieval; making reinforcement possible. (Gagné, Briggs, & Wager, p. 182). It is not at all clear what is meant by *activating retrieval* at this point of the instruction. In terms of learning, you are trying to determine if the learner has acquired the information, organized the information appropriately, is able to retrieve the information, and/or is able to use the information in a problem solving setting. If you take Anderson's (1987) view of the acquisition of procedural knowledge, assessment must take place as close to the learning (in time) as possible. In this way, incorrect subprocedures can be corrected before they become too well established (remembered). Some other considerations, besides those implicit in the above discussion, is the the notion of recall versus recognition. Among other things, research has shown that learners who expect to be tested in a recall format (essay, problem solving test) perform better than those learners who expect a recognition format (multiple choice, matching, fill in the blank) regardless of what format the actual test takes. A second consideration might be between reconstructive and reproductive processes. With reconstructive processes, the gist of the information might be important while with reproductive processes the verbatim recall might be important.

9. Enhancing Retention and Transfer. Providing cues and strategies for retrieval. (Gagné, Briggs, & Wager, p. 182). Gagné, Briggs, and Wager (1988) suggest that retention can be enhanced by providing reviews of the content at spaced intervals (distributed practice). In order to enhance transfer, they suggest that practice be provided in widely varying contexts (again, multiple encoding links lead to more retrieval links). Transfer is widely accepted as a desirable outcome of learning. However, there are levels of transfer. For example, a math teacher might build as a rationale for doing Algebra the idea that the problem solving in the Algebra context (Two trains are heading towards each other at 60 mph and 40 mph respectively....) will transfer to other problem solving contexts (resolving marital problems). The research on this far reaching type of transfer is quite small. However, it is quite possible to help learners to transfer to similar

types of problems. For example, you can do a variety of motion problems where the trains or boats or planes are heading towards or away from each other and focus the instruction on those aspects of the problem that are similar (*providing cues*).

Another aspect of transfer is the use of conceptual models (Mayer, 1989). Mayer has demonstrated several times that by using a conceptual model for the presentation of the content to naive learners, the learners are better able to remember (*retention*) and *transfer* to other areas. However, we have already suggested that this is an aspect for consideration in another event -- Presenting the stimulus material.

Not all of the events of instruction match up perfectly to cognitive theory (e.g., Brown, Collins, and Duguid's (1989) cognitive apprenticeship or microworlds from constructivistic learning theory (Harel, & Papert, 1990)), but then again not all swans are white. Instructional development is in a state of change, as it always has been, and as it probably (and hopefully) always will be. The trick is to learn from progress, and to make the change process evolutionary, and not revolutionary. We are advocating the further study of new learning theories and how and if they are complimentary to our existing theories of instructional development. By doing this we can learn how to make instruction more effective and efficient, and keep the field of instructional development in a state of growth.

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